

## Senate Commerce, Science and Transportation Committee Holds Hearing on Space Shuttle Investigation and Future Space Policy

MCCAIN:

Good morning. Today's hearing is the second in a series of hearings to examine the causes of the Space Shuttle Columbia accident. I welcome Administrator O'Keefe and Admiral Gehman and look forward to hearing from them on the status of the investigation, including the Columbia Accident Investigation Board's most recent recommendations and NASA's plan to return the space shuttle flight program to flight.

It is extremely important that congressional oversight committees have access to all critical information in this investigation. And I want to fully impress that fact on our witnesses. I repeat -- it is extremely important that congressional oversight committees have access to all critical information in this investigation.

In addition to the Columbia accident, we will also discuss NASA funding concerns. And I'm greatly troubled over the increasing pattern of congressional earmarking. And we may learn that the funding directives to members' priority projects, at the expense of NASA's own funding priorities, have led to grave consequences.

Congressional earmarking of NASA funding increased from \$24.7 million for fiscal year 1998 to \$167 million in fiscal year 2003, a 576 percent increase in NASA earmarks. Examples of such earmarking, which have prevented NASA from allocating funding to programs that it considered to be most critical include: \$15.5 million for the Institute for Scientific Research in Fairmont, West Virginia; \$7.6 million for hydrogen research being conducted by the Florida State

University system; \$2.25 million for the Life Sciences Building at Brown University, Providence, Rhode Island; \$1.8 million for the construction of a Gulf of Maine Laboratory at the Gulf of Maine Aquarium Foundation; and \$1.35 million for expansion of the Earth Science Hall at the Maryland Science Center in Baltimore, Maryland. These are just a few of the egregious earmarks that have little or nothing to do with NASA, or certainly its core mission.

While the level of congressional earmarks have grown, NASA's overall budget has remained relatively stable. As a result, NASA has been forced to do more with less money, while facing deteriorating infrastructure and safety concerns. I'd like to hear from Administration O'Keefe and Admiral Gehman and learn their views on how this pork barrel spending may have affected NASA operations, including the space shuttle program.

In addition, I am concerned that it appears that NASA tries to curry favor with a broad base of members by trying to ensure that programs affect as many states as possible, even when this may not be the most effective or productive use of resources. Even more remarkable is when NASA funds a \$900,000 computing, information and communications program for mobile, wireless and broadband Internet capability that had been, according to NASA's fiscal year 2003 operations plan -- quote -- "inadvertently dropped as an earmark" -- unquote -- from the 2003 Omnibus Appropriations Conference Report.

I urge the administrator to conduct a thorough review of all NASA's funding plans to ensure they are oriented to meet the legitimate needs of NASA's missions.

Other important issues that need to be examined today include: NASA's culture and the concerns of NASA employees about Columbia's safety; the National Imagery and Mapping Agency and why it was not used to take on-orbit images of the Columbia -- we have heard conflicting stories on that particular aspect of the Columbia tragedy and we hope that will be cleared up; the impact of

the Columbia accident on the construction of the International Space Station; the safety of the Soyuz, which is currently the only transport to and from the space station; and congressional access to privileged information from the CAIB investigation.

I look forward to an informative hearing this morning and, again, thank the witnesses for appearing today.

Senator Hollings?

HOLLINGS:

Well, thank you, Mr. Chairman. I'll just file my prepared statement, with the only comment to the effect that you will get an informed hearing. The distinguished chairman has just allowed that we expect, at the congressional level, to receive all statements, all materials and everything else of that kind. And he more or less gives that command, like he's still in the Navy. But that isn't what's happened.

As I understand from the news reports, you have given confidentiality to those giving statements, to make darn sure that the Congress doesn't receive all materials of the investigation. So point one: I'm disturbed about the investigation itself. Because we went through with this on the Challenger. And it looked like the same act, same scene, with no regard for safety, in the Columbia thing.

But I'll just leave it at that. And we will have some questions.

MCCAIN:

Thank you, sir.

Senator Sununu?

SUNUNU:

Thank you, Mr. Chairman.

Welcome, Administrator O'Keefe and Admiral Gehman. Looking forward to the testimony. I know there has been a tremendous amount of work done. And I think, at the very least, we owe a great deal of thanks to all of the personnel that have been on the ground, volunteers. I mean, literally, thousands of them, working hours and hours and hours to make sure that, to the best of our ability, we have as much material as possible to draw sound conclusions from through the investigation.

So welcome. And I look forward to your testimony.

MCCAIN:

Senator Wyden?

WYDEN:

Thank you very much, Mr. Chairman. I too want to welcome our witnesses and thank them for their cooperation. There are a number of areas I want to explore this morning.

One involves the preliminary recommendations that have been received from the Accident Investigation Board. The two preliminary recommendations, one calls for the comprehensive inspection plan to determine the structural integrity of the reinforced carbon-carbon system components. And the second is to modify NASA's agreement with the National Imagery and Mapping Agency to use satellites to make on-orbit imaging for each shuttle flight a standard requirement.

When I learned about these two recommendations -- and I recognize these are both preliminary -- what really struck me is: why weren't these recommendations put in place prior to the tragedy? And I think this would be an area that I would want to explore with you, Administrator O'Keefe. Because you just say to yourself, you know, it seems really tragic that current inspection techniques are not adequate to assess the structural integrity of the carbon-carbon supporting structure and attaching hardware.

And I think my questions in this area would be twofold: one, why wasn't it done before the tragedy; and second, what's being done to implement the recommendations?

The other area, Mr. Chairman, that I want to look at is this question of the way technical analyses are used by the agency. And of course, the concern here, as has been reported widely in the press, that NASA managers refused to seek the photographs of the damaged shuttle. And the engineers were making pleas that it be done so.

And I recognize this deals with the memorandum that you all sent to the committee. But I think I would like to explore this some more as well and will be asking about that, Administrator O'Keefe.

But Mr. Chairman, I'm glad you are doing this. To me, there really isn't anything more important than the oversight function of the United States Congress. And I appreciate the fact that you are bringing us here, on a host of the key issues, to look at these matters. And I look forward to our witnesses.

MCCAIN:

Thank you, Senator Wyden.

Senator Allen?

ALLEN:

Thank you, Mr. Chairman, for having this hearing.

And Administrator O'Keefe and Admiral Gehman, thank you for appearing before this committee. And more importantly, I want to commend you for your tireless, your honest and your open efforts in the last three-and-a-half months since this disaster occurred.

Briefly, I'd like to make three points. First, Admiral Gehman and Administrator O'Keefe, I think you all have done an outstanding job in responding to the concerns of Congress and responding to our concerns, in so far as the investigation board and its independence from NASA.

When one looks at this tragedy compared to that of the Challenger, the Columbia investigation, in my view, is certainly more expeditious and certainly more forthright. Not to criticize the other, but I think you have made a substantial, significant and noticeable improvement in that openness, forthrightness and the speed in which you are sharing that information and getting on it. I think that those efforts are helping us -- and you all -- to find the underlying and contributing causes of this tragedy.

Secondly, I want to echo and underscore previous comments about NASA's human space flight program. Virtually every aspect of NASA depends on the success of the shuttle and the human space flight program. Generally, I look at space flight as a means to a greater end, which is research and discovery and exploration. And I know the brave crew of the Columbia engaged in a wide variety of scientific research -- in fact, research that only could be done in space.

I truly believe that if anything good can come out of this tragedy would be a reinvigorated focus on NASA and its primary mission of scientific research that actually benefits people here, life here on

this planet. Some of the comments of the chairman, in my view, to the extent, I guess, you end up funding extraneous matters that are not the primary focus of NASA, diminishes that capability.

Now finally, thirdly, I have previously raised concerns about NASA in the area of one of its primary functions, which is aeronautics and also, in so far as space is concerned, the advancements in technology; specifically, embracing some of the advancements in nanotechnology, that I know Senator Wyden shares my views on, as well as automation and robotics, that could potentially minimize the risks associated with human space flight.

I am interested in learning any specific areas where NASA is embracing some of these advancements in automation and robotics, which I believe are essential for us here in Congress, as well as NASA, to work together to get that right balance of humans, as well as the advancements in robotics and automation, to function in these scientific research projects that are done in space.

And I thank you, Mr. Chairman, for having this hearing, and thank both gentlemen for your leadership.

MCCAIN:

Thank you.

Senator Breaux?

BREAUX:

Thank you, Mr. Chairman. Very briefly, I think that it's good that we're having this hearing. Out of the tragedy of the Columbia, hopefully, can come some good. And hopefully, the good will be an assessment of where we are and where we need to be, what steps need to be taken to make sure that the launch vehicles for future flights are safe, dependable. And I think that hopefully we can start

focusing in on what we need to do to meet the needs of the future after we determine the reasons for the accident itself.

One of the things that has given me great concern is that there is no replacement vehicle for the space shuttle. Not only is there not a replacement vehicle, there's not even anything on the drawing board.

And if somebody came to the administrator tomorrow with the best designs for a new vehicle, it would take a substantial amount of time to put that vehicle into construction and ultimately into use. I mean, these are 15-, 20-year projects at the very least. And right now, I think the failure of all of us is that we have not made preparation for what's going to come after the shuttle.

And it's not a one-week proposition. It's a 15-, 20-year proposition. And right now, there is nothing on the drawing boards. And I think there is probably a lot of fault to go around for all of us as to why that is the situation.

But we thank our witnesses this morning.

MCCAIN:

Thank you, Senator Breaux.

I want to thank Administrator O'Keefe and Admiral Gehman for their outstanding work. We will have some tough questions. And I hope we can have some meaningful exchanges. But none of that, I believe, will diminish the respect and appreciation that we have for both of you and your service to this nation. We thank you.

Administrator O'Keefe, begin with you, please.

O'KEEFE:

Well, thank you, Mr. Chairman and members of the committee. Much has happened, I guess, since we last had an opportunity on February 12, before this committee and the joint committee, with the House Science Committee, to discuss the specific aspects of the Columbia tragedy.

First and foremost, over the course of the six weeks after the tragedy, I have personally attended nine separate memorial services and every funeral, which I am still stunned, I think, by the extraordinary effort that the Air Force and the Navy particularly went to, to render full honors to all of the members of the crew of Columbia. It was an extraordinary effort and I think honored and respected their memory in an extraordinary way.

The recovery effort that occurred over the course of the last 100 days was equally impressive and one that -- I don't think anybody expected we would recover much more than about 10 percent of the orbiter. Instead, over the course of that time, better than 20,000 people in 200 different federal, state and local agencies and departments from the state of Texas, the state of Louisiana, the various communities, as well as the federal government, conducted the most impressive interagency, intergovernmental recovery effort that has ever been recorded.

And in the course of that time, there was no less than about 6,000 people in the east Texas, west Louisiana area that were engaged actively, every single day, in working through an area that's depicted on this particular chart, from a little southeast of Dallas, Texas, into Vernon Parish in Louisiana, that's the equivalent of 250 miles and about 10 miles wide. It's the equivalent in acreage of the size of the state of Rhode Island.

And the teams from NASA, the U.S. Forest Service, the Environmental Protection Agency and countless state and local agencies and departments literally walked every single acre of that area and recovered now what is the better part of about 40 percent of the orbiter and what's equivalent to about 83,000 tons of the

orbiter itself, which has now been shipped to the Kennedy Space Center. Our activities in that area demonstrate, I think, some of the most remarkable efforts at interagency cooperation that is a model for how that cooperative effort can be conducted in pursuit of a common objective in ways that -- there were absolutely no, in every single trip I made to the area, was stunned to see that there were absolutely no conflicts between and among agencies, between state and local officials.

The Federal Emergency Management Agency conducted the primary coordination of that effort. But it was one that required little cooperative instance or instigation on their part. It was extremely well handled and one that we're extremely proud of and thankful to the governor of the state of Louisiana and the governor of the state of Texas for their extraordinary contributions, as well as cooperation, as we worked through this.

This particular land area, I think is, I guess in the category of remarkable developments as well, is occupied by about 400,000 citizens. And stunningly, in as much as this was tragic and horrific for the loss of seven very important lives, it is amazing that there were no other collateral damage efforts as a result of it. No one else was injured. All of the claims have been very, very minor in dealing with these issues.

But an awful lot of debris was recovered. And the wreckage itself has been, again, now reassembled in large measure at the Kennedy Space Center, which is informing the investigation in ways that are exceeding our expectations in many respects. I'll certainly defer to Admiral Gehman on his commentary on that point.

As it pertains to the cooperation with the board itself, it has been -- there is no element of what they may desire, require or need that we have denied. And indeed, our effort has been to cooperate with the board on each and every issue as necessary, in order to reach a common objective, which is to determine the truth, find the facts and the evidence to support exactly what happened and how we may go

about the process of fixing it and return it to flight safely, as soon as we can.

In that regard, the return to flight efforts that we have engaged in is, rather than wait for the final report to be released, as Senator Breaux alluded and Senator Wyden as well, there are a series of recommendations that the board has released as findings and recommendations thereafter that we are beginning to implement now, rather than waiting for that activity to be in its totality.

Our effort is to follow the better than nine separate public hearings that have been conducted, as well as the public commentary that has been offered by the board, in order to inform the kind of approaches we need to take to return to flight expeditiously, but safely, in doing so. So there are a range of different recommendations and findings that they have come up with that we are beginning now to implement and will continue, throughout the course of their activity, to engage in that activity as rapidly as we possibly can.

Finally, I do want to thank the board members for their diligence, their literally six, seven day a week activity that they have conducted for the past 100 days. They were appointed and assembled on the very first day of the accident and have been unceasing in their efforts since then to find the truth and to find the evidence to support what happened on that day, so that we may make those corrections and move on to safe flight again.

In particular, I want to thank Admiral Gehman, who responded to my call hours after that horrific accident and pulled him out of retirement -- blissful, I think, retirement -- in which he certainly had lots of other things to do than return to public service in this situation and has been relocated to Houston, Texas for the entire three-month period since that time and has conducted what I think is a very thorough effort to date at this point.

I thank you, Mr. Chairman, for the ability.

MCCAIN:

Thank you.

Admiral Gehman?

GEHMAN:

Good morning, Mr. Chairman, Senator Hollings, members of the committee. I appreciate the opportunity to appear before you this morning.

Rather than read my statement, I'll just ask that it be entered into the minutes. And I'll just...

MCCAIN:

Without objection.

GEHMAN:

Thank you very much. And I'll just make a couple of brief points and we can get on to the business.

First of all, I would like to introduce a couple of my fellow board members who are here today. Seated behind me is Mr. Steve Wallace, the chief of the Aviation Safety Division of the FAA and Dr. John Logsdon, from George Washington University, who is the chair of the Space Policy Commission.

MCCAIN:

Welcome.

GEHMAN:

And also, the real strength behind my move to Houston, my wife is sitting behind me too, Senator McCain.

MCCAIN:

Welcome, Mrs. Gehman. Thank you for your service.

GEHMAN:

Members of the committee, I am delighted to appear before you and answer all of your questions fully and completely on any matter that you would like to hear about. I have to say, however, that this report is not written. And I will be delighted to give you my personal opinion.

But this a board of 13 members, some of whom feel very strongly about some of these matters. And I don't want to overstate or get ahead of my headlights here. Many of the things that you are interested in, the board has not decided upon.

So I'll have to caveat my answers by when I know that the board is comfortable with a subject or when the board hasn't even addressed the subject yet and give you my personal opinion. So if you will excuse me for that caveat right at the beginning, that I'm delighted to give you an interim report, but that we haven't written this report yet.

The intent of our board is to provide you with an independent analysis and an independent review of not only this accident and what caused it, but also a deep, rich, complete and intrusive inquiry into the entire manned space flight program. The goal of our board is to hit the target. The target is determined by you, the members of Congress.

And in my dialogue with members of Congress, which I found very helpful, I have noticed that the target tends to move a little bit, which is perfectly all right. And it's that dialogue which allows me to adjust my aim and adjust my sights, so that we meet your requirements.

Several members of Congress have indicated to me that when my work is finished, yours is just beginning. And please don't hand me a half-baked loaf. And I understand that.

Our intent is to give you a complete, rich, deep review of this program, a review which has not been conducted before by any other board. And in order to do that, we are using some old, well-proven, tested tools that get into the culture and the attitudes and the processes and the management and the climate, that cannot be gotten into by any other way.

Mr. Chairman, you as a naval aviator are very familiar with the safety review process that's used in several agencies. And we have found, over the years, that that's a process that allows you to get a look at an organization that you cannot get by any other process.

So you really have two investigations in one here. You have an accident investigation -- what happened -- that's being done in complete public, with full disclosure, public hearings, interim recommendations, lots of press conferences, plenty of oversight. And then we have a safety investigation, which is being conducted in accordance with procedures that have been set up by several agencies in the executive branch, which allows you to get the kind of look that you cannot get any other way.

It is the opinion of the board that that will allow us to write a report, which will be of aid to the Congress in a way that no other review of NASA has ever given you before. And it cannot be done any other way, in our opinion.

The board is fully aware of the oversight responsibilities of Congress. We are fully aware of your requirements. And we are

meeting right now -- our staffs are meeting right now -- to find a way to fully meet all of your requirements in some fashion or another, which I am advised, even though I'm not an expert at this, that these processes have been worked out between the executive branch and the legislative branch many times before. And there are processes to allow you complete access to anything you want to see.

So until we agree on all what those processes are, I don't want to get ahead of myself here. But I don't see this as a problem, meeting the oversight responsibilities of Congress in a way that's satisfactory to you.

Meanwhile, the board wants to hold on to this tool, which is going to give you a better product and a product that you will not have had the advantage of having before. Enough said on that.

This board is completely independent, contrary to some of the -- I've got to watch my words here -- headlines of the past. NASA does not pay our salaries. You pay our salaries. The Congress enacted a \$50 million grant to conduct this investigation.

NASA keeps the books for me, but I spend that money. So somehow suggesting that members of this board are influenced by the way the records are kept, I find to be somewhat naive.

I also would like, on behalf of the board, to recognize and acknowledge the work of the thousands and thousands and thousands of volunteers who have spent weeks and weeks walking through the state of Texas picking up debris. This serves two purposes, one which is a public safety purpose, because some of this debris is hazardous. And to get it up and out of the ground and out of the streets and schoolyards and public places is very important.

The second point that I would make is that it turns out that the analysis of this debris and the reconstruction of this debris has been very important to this board's work. It turns out it was more

important than we ever have thought it would be. We have learned a lot of things from analyzing and learning from the debris.

So it turns out that that work turned out to be more critical and more important than we thought it would be at the first. And we owe a great debt of gratitude to a whole lot of people who are never going to get their names in the paper and their pictures in the paper. So I would like to second that, too.

Let's see -- and I think that, with the exception of the points that I make in my prepared statement, I think that I best could serve this committee if I stopped and responded to the questions.

Thank you for the opportunity, Mr. Chairman.

MCCAIN:

Thank you. Thank you, both.

There are several issues that I would like to address and may have to have subsequent rounds. But the first issue I want to discuss with you concerns the issue as to whether satellite photos could have been taken of the Columbia. And if so, would it have mattered in helping prevent this tragedy?

Now here's what happened from my standpoint. I was notified shortly after the tragedy, in the most highly classified fashion, that the National Imaging and Mapping Agency had offered to take satellite photos of the Columbia, in order to ascertain whether if any or the extent of damage as a result of the foam striking the capsule after -- on launch, as we all know.

Now I was originally briefed that the offer was rebuffed by NASA and that the offer had been made on a couple of occasions. I consulted Senator Hollings. And we discussed it and sent a letter to Administrator O'Keefe, asking for information concerning this situation.

It is still not clear to me what happened, who is responsible and whether a picture or imaging could have been rendered, if it had been given sufficient priority, which may have provided information that would have at least alerted NASA and people on board Columbia that there was a significant problem.

So Admiral Gehman, you may not have reached any conclusion on that yet. This may be one of those. But I would like to hear information from both you and Mr. O'Keefe, beginning with you, Administrator O'Keefe.

O'KEEFE:

Yes, sir. Thank you, Mr. Chairman.

I am certainly going to be a bit circumspect in the response, given how cherry the intelligence community is about discussing the full extent of the quality of the imagery that is made available or the products that are available from the intelligence community. But as we have discussed...

MCCAIN:

Could I just remind you, Senator Hollings and I communicated to you in a classified fashion. It wasn't until information was in the media that we felt free to discuss this issue.

O'KEEFE:

Oh, yes, sir. No, no.

MCCAIN:

Go ahead.

O'KEEFE:

And in response to your joint letter, recall that immediately we responded on an unclassified basis, as well as classified information, to provide that information as well. And we've discussed this several times in closed session.

Nonetheless, the procedure that was followed during the course of this operation and prior was the National Imagery and Mapping Agency had an agreement with NASA that upon our request, they would provide products from the assets that they operate. That procedure required a level of import that had to be attached to it -- whether it was routine, an emergency, urgent, et cetera. That kind of "how serious is your problem?" essentially was the nature of the MOU.

In this particular context, there was certainly the dialogue that goes on every day between NASA and NIMA on matters of availability of assets, in which there were offers rendered, in which they asked that there be some attachment of urgency to it. Based on all of the mission management team's assessment in that 16-day mission, their judgment was there was no safety of flight consideration. So we certainly asked the agency to make available those products, to the extent that was available and easy to do, on a normal, routine basis.

Given the other priorities, which we are totally unaware of, that NIMA has and has to respond to, their judgment about exactly how that is made available is their call. If we had said, "We have an urgent matter. We need to take, use or employ your assets for the purposes of releasing those products," they would have done so. We had no basis upon which to determine urgency.

That was a judgment call. We now realize that, given the circumstances, that may have been of greater utility. But at the time, in order to meet that criteria, we would had to have put a matter of some urgency attached to it.

As a consequence of this and based on the findings and recommendations of the Columbia Accident Investigation Board, which was among the first two they have released, I have re-enjoined with General Clapper at NIMA and have asked him specifically to let's disregard the MOU -- let's rewrite it -- and to simply make available imagery on every future operational mission, as it comes available, period, without any qualification of its urgency or emergency requirements or anything else.

The quality of that imagery, of course, always depends upon a range of factors. And as a consequence, there is no comparability between each and every available product, as it were. So as a consequence, we will get widely ranging degrees of quality of what may be useful in the future. But nonetheless, we will get it. And there will be no ambiguity about that procedure.

That MOU is being -- the memorandum of understanding between the two agencies is in the process of being redrafted with that specific understanding between the two agencies, unambiguous.

MCCAIN:

You have no idea as to whether that imagery would have revealed that there was a problem?

O'KEEFE:

Again, without describing what the extent of their quality is, let me simply say that the Tom Clancy novels would have us believe that the quality is extraordinary. There may not be as close to that reality as the novelists would have us believe.

And on that basis, it depends on a whole range of variables. And it is purely speculation on whether or not any of the products would have been of sufficient information to have given us any understanding.

Indeed, I think Admiral Gehman's board investigation process, while it has not yet determined what was the cause, the initial factor that caused this, may well have been something that might not have been even determining, based on any use of any product from any intelligence source.

MCCAIN:

I appreciate the indulgence of my colleagues. My time has expired. But I would like to hear from Admiral Gehman on this rather important issue.

GEHMAN:

Thank you, Mr. Chairman.

You happened to hit on a good first question because, as you may know, the board has issued a recommendation on this subject. And therefore, this is something the board has agreed upon.

My evaluation and when we write this section probably will be a little more critical than the administrator's description. There are a number of issues here. We will attempt to pin this issue down in our report.

But there were a number of bureaucratic and administrative missed signals here. There is no one person responsible. There are a whole lot of people responsible.

The system didn't work in this particular case. And I wouldn't blame that on any one person.

We have listened to a lot of people and we've gotten quite a bit of testimony on who said what to whom. And we've tracked the issue. We have diagrammed it out. And we are a little disappointed at how the process worked. That's why we issued this recommendation.

We were a little disappointed in what some of the senior people knew and understood about how you get these images and what the images could do for you. They didn't understand. Some people in decision making processes didn't fully understand what they were talking about here.

In some cases, people made decisions based on erroneous understanding of what was happening. There were missed signals going up. And there were missed signals going down, too.

And we are not quite so happy with the process. We thought that there was some administrative and bureaucratic missed opportunities here. So we will be a little more critical of the process in our report.

Now whether or not it would have made any difference, we will not be able to speak to that. Since we don't know the mechanical, physical initiating event, we do believe that the orbiter entered the Earth's atmosphere with a pre-existing flaw. But that flaw could be as small as two inches by two inches or it could be larger.

So whether or not any photography could have detected that is purely argumentative. But when we speak to the old timers, some of the original flight engineers and flight directors and astronauts, they give us a slightly different view.

They all say, "None of that makes any difference. This is a test vehicle. Of course, you want pictures, just so you know. And all the rest of this stuff is bureaucratic fumbling and bumbling."

So I can answer part of your question. The board has investigated this, as illustrated by our interim recommendation. We have satisfied ourselves that this process didn't work, that it was no one person's failure. But we cannot determine with any satisfaction that it would have made any difference.

I hope that answers your question, sir.

MCCAIN:

Senator Hollings?

HOLLINGS:

Thank you, Mr. Chairman.

Admiral Gehman, right from the get-go, what about the chairman's observation that we need have every statement, every bit of information that you folks on the commission of inquiry have made? Can we have all of those? Or has confidentiality agreements been made to give cover for some of those statements that, in other words, cannot be made public or cannot be given to the committee? What's your answer to the chairman's request that we have all the information you have?

GEHMAN:

Thank you, Senator.

As I indicated in my opening remarks, it is our belief that the Congress of the United States will get a better report from us...

HOLLINGS:

Well, I know we're going to get a better report. Let me ask: have you given confidentiality agreements to anybody in this investigation, whereby their statements will not be available to this committee?

GEHMAN:

We have, Senator.

HOLLINGS:

There you go.

GEHMAN:

But that doesn't mean that their statements won't be available to this committee. We have conducted witness interviews, in accordance with the safety procedures used by several branches of the executive branch. And there are processes by which this committee can have access to those. And as I indicated in my opening statement, those processes are now being negotiated by our staffs.

HOLLINGS:

Well, I'm not clear yet. One minute you say you have given confidentiality agreements. And then you've got to argue with lawyers and so forth as to whether we get them. But that's by the pale.

The real important question is: could anything have been done to save those astronauts? Now we know the ingenuity in the Apollo 13. And you've got -- Admiral, you and I have discussed it -- an ingenious group. And they know how to work and go and everything else of that kind and implement.

I disagree with the distinguished administrator's observation that there was no urgency. The truth is that within 81 seconds, we knew that insulation had caused damage. The truth is that thereafter, the engineers were calling up and asking. And they're calling up and asking for an investigation and pictures and everything else like that.

Boeing, I guess it was, made the investigation. But they didn't report until day 12. Now that there would go along with the administration's "no urgency."

But you had urgency on the other side, namely the mapping agency was calling up and saying, "We can get pictures. We can get pictures." You had the engineers and everything else.

You call it bureaucratic missed signals. But really, it wasn't until, like I say, day 12 that he found out, "Wait a minute, we should have done something."

Could anything have been done?

I've talked to an astronaut or two. And they think that yeah, you could have gotten another shuttle up otherwise. You could have turned that around for re-entry so the cool side would be to where the damage had been inflicted and that kind of thing. There are all kind of maneuvers could have been made.

But it just looks to me like somebody that saw that in charge just, all of a sudden, just crossed their fingers and said, "Well, it's worked before. Let's hope it works again." And just cool it, cool it.

"No, no. We don't want any pictures." In other words, they were refusing to get the pictures, not on account of urgency. The urgency was there.

What's your comment, admiral?

GEHMAN:

Senator, we as a board, early in this investigation, considered the question about what, if anything, could have been done. How close did the astronauts come to surviving this?

And in the early part of this investigation, the board decided that there were still too many emotions and too many egos and too many feet stuck in concrete to address that. Now, three months later in this investigation, we know more. Some of the emotions are off the sleeves now a little bit. And we have just directed and just begun a formal inquiry into what could have been done.

That inquiry is about 10 days old. We think that the emotions are out of it now, some of the reluctance to discuss these things. We've got a little separation of time now so people can be cooler about this.

That investigation is going on right now, jointly with our board and a bunch of real smart people from NASA. And it is headed in a direction -- it's too early to say. We haven't found any magic fix, let me put it that way.

But I will say that it's inconceivable that we would come up with the answer that we could do nothing. I mean, of course we would do something.

And we have determined that, for example, that the estimate of how long the orbiter could just hang up there, for example, the harder we dig into that, the longer that date gets. It turns out that they could have stayed in orbit a couple more days, more than a couple more days.

It turns out that the more we dig into this, the longer that number gets. And it gives you more opportunities to do things.

And even if we came up with a fix that only had a 10 percent chance of succeeding...

HOLLINGS:

We would have tried.

GEHMAN:

Of course, we would have done something, absolutely. So thus far, this review -- which I have looked at myself, I found it to be pretty aggressive and pretty well thought out -- hasn't found any magic formula, but has found several steps that could have been done to mitigate this. We may find more.

But this is a fairly -- this is tough work for people who are closely associated with the program. And they're doing a good job of it. So maybe I'll be able to get back to you later on.

But doing nothing is obviously not the right answer.

HOLLINGS:

How about Mr. O'Keefe?

O'KEEFE:

Thank you, Senator. I don't disagree with your assessment, Senator. It was a judgment call. It was clearly the wrong judgment. And as a consequence -- I mean, what we know now, hindsight being the circumstance, there are a variety of signals that could have gone or told us what we should have been observing and what we could have corrected.

Nonetheless, the judgment by the mission management team at the time was they looked at the 16-day mission. They said every one of the things we've observed, all the spirited debate that you refer to -- you're exactly right, lots of dialogue back and forth -- in the end, they made a determination and said, "Do we think this is a more urgent circumstance than we have ever experienced before?" And the answer, rightly or wrongly, was they felt, in their judgment, this was not outside the normal. That certainly proved to be an erroneous judgment.

So looking back on this, there is no question. The clarity is there.

At the time they went through it, the mission management team certainly looked at that. I concur entirely with Admiral Gehman's assessment.

Had there been a different determination, we would have spared nothing to find a way to return the orbiter and the crew safely to this planet. No question.

HOLLINGS:

But just one little observation. Of course, it does look like the judgment was made that it was urgent and it was perhaps a fatal injury to the shuttle itself. And they determined to make sure that

that was not proved by not taking pictures and those kind of things. Those are the things that worry us on the committee.

O'KEEFE:

Yes, sir.

HOLLINGS:

It looks like they knew it and there was the urgency and they knew about the urgency and everything else, but they tried to sort of cover up the urgency.

O'KEEFE:

Well, if I could, Senator, I entirely concur in Admiral Gehman's assessment of this. When you look at the memorandum of agreement between NASA and NIMA, there is nothing that really jumps out at you and says, "Geez, this looks like it's going to be a really bureaucratic procedure."

In practice, it proved to be absolutely impossible to implement correctly. It was the wrong way to go about doing it. We have corrected that. There is no ambiguity about this point.

General Clapper and I have had some very specific, direct words on how to arrange this. And there is going to be no ambiguity on this point in the future. But there was nothing that would scream off that page of the memorandum of understanding that says, "What we have is an impractical or an impossible situation."

In practice, I agree entirely with the way Admiral Gehman described it. It is something that -- you've got folks who don't know or were not aware of the quality of what could be available and then a procedure that ultimately turned on the determination of NASA about what other priorities the intelligence community may require, singularly unqualified to make that judgment call.

And so, as a consequence, it became -- it ground itself down to the null set. And that's what we have fixed. There is no ambiguity about this procedure any longer.

It is infuriating to see how that process played out. And I share your absolute frustration with the fact that that should not have occurred that way.

MCCAIN:

Then it's equally infuriating that no one is responsible. Those decisions weren't made by machines. Someone is responsible.

O'KEEFE:

Yes, sir.

MCCAIN:

Senator Allen?

ALLEN:

Thank you, Mr. Chairman. Let me switch from this line of questioning to the current operations. The space shuttle, while it's an old craft, is still the most capable, as it's reusable. It can carry loads as well as, obviously, crew members up to the space station. It's clearly a national asset that is currently grounded.

My question is regarding the future of the shuttle and the International Space Station; specifically, what is our strategy that will be guiding the operation of the space station while the space shuttle is grounded?

O'KEEFE:

Yes, sir. Thank you.

Our partnership with the International Space Station partners demonstrated the depth of that partnership by responding and stepping up when we need that capability most. In particular, our Russian partners in the Rosaviakosmos, the Russian space agency, have responded in a remarkable way, by not only accelerating the logistics flights that are necessary to resupply the International Space Station, but also to honor their commitments previously made to launch the Soyuz spacecraft, which will now be used for crew rotation purposes.

I was in Russia the weekend before last to -- after several tense hours -- to welcome home the Expedition 6 crew: Ken Bowersox, Don Pettit and Nikolai Buderin. And just days before, Ed Lu and Yuri Malenchenko were launched on Soyuz to man the space station as it is today on Expedition 7.

So that rotational pattern will continue. And we will then maintain a capability there that, again, our International Space Station partnership has stepped up to the task of maintaining that capability, independent of the shuttle's operation. The catch is we can't continue to build the International Space Station -- complete it -- until we return to flight safely. And so the imperative for moving ahead, finding the problem, fixing it and responding by returning to safe flight, is the imperative of building the International Space Station and conducting the activities that we have planned and worked through for so long.

ALLEN:

Well, implicitly, if we're doing simple math, we're sending two crew members now rather than three, which then gets the question of its capabilities and can two do as many as three? And then following that is what's the strategy of NASA, in so far as the balance between the use of manned space flight versus robotic satellites?

O'KEEFE:

Yes, sir. No, the maintenance of Expedition 7, as well as each crew hereafter that will be launched on Soyuz or recovered by the return of the attached Soyuz flight that's aboard now, is what is required to maintain continued safe operations of the International Space Station. It is a lights on, fluids running, kind of maintenance capability -- and some science. There is not a complete diminution of that. They are not just there as an engineering or maintenance crew. But it does guarantee safety of flight operations and keeping it at the appropriate altitude in order to maintain safe operations.

So the diminution of one is more a function of how many folks can you support with logistics flight, the progress flights that are sent now five a year, is what we're planning, in order to maintain the logistics, the consumables -- food, water, repair, spare parts, et cetera. And that's adequate in order to support two, not three.

We could have maintained a longer or more extended presence of three crew members through early fall, but that would have drawn down the consumables faster. So we elected to make the change to two crew members earlier.

In terms of what is the future of human space flight and the imperative thereof, certainly this tragedy reminds of us of the extraordinary risk that is taken when humans are engaged in space exploration. And in doing so, it means we have to absolutely convince ourselves of the imperative of why humans need to be involved in certain mission activities.

As it pertains to the operations aboard International Space Station, I think, in the opening comments from so many members here of the committee, particularly your statement that this be a science- driven research enterprise; indeed, that is its primary purpose. A lot of that can be done robotically. A lot of it can be done remotely. Some of it can't. It requires human interaction and activity in order to divine the kind of science and research activities and experimentation that's necessary.

The Hubble Space Telescope, classic example again of why human space flight is a very important element of the overall equation. Because when we launched that capability 10 years ago, it was determined to be out of focus and was widely deemed to be a \$1 billion piece of space junk.

It has come back from the ashes as a consequence of that because of human interaction. Were it not for the capacity on the part of humans to make adjustments to that piece of machinery that couldn't be done remotely, it would have remained a \$1 billion piece of space trash.

Today, it's rewriting the astronomy books, based on what we're learning from it, because of human interaction. So we've got to be very selective, very careful on how we engage in human space flight and expose the risk only when you see the imperative is there for human interaction required. But beyond that, I don't see a circumstance under which we would eliminate it entirely.

ALLEN:

But you do see an increased value in it?

O'KEEFE:

Yes, sir.

ALLEN:

As advancements go forward?

O'KEEFE:

Absolutely. No question at all.

ALLEN:

My time is concluded. Thank you both.

O'KEEFE:

Thank you, Senator.

MCCAIN:

Thank you.

Senator Wyden?

WYDEN:

Thank you, Mr. Chairman.

Gentlemen, thank you. And begin with you, if I might, Mr. O'Keefe. And I'm going to explore something with you that really goes back to the days when I chaired the Subcommittee on Science, Technology and Space, now chaired very well by our colleague, Senator Brownback.

And my sense, Mr. Administrator, that there is really an urgent need for a thorough overall of the way people within NASA communicate with each other. If you look, for example, at the kinds of things that we're talking about here -- and Senator Hollings and Chairman McCain have gotten into it -- what we see is it just doesn't seem that the people on the front lines -- the engineers -- seem to feel that they're getting through to people up at the top. And you hear that again and again and again.

Now I recognize that we're still in the preliminary kinds of stages in this area. But I would be interested in your sense at this point: a, whether you think that there really is a need for significant change at NASA with respect to how people communicate with each other, and what you think some of the elements of -- if you feel that way, what some of the significant elements of those changes ought to be?

O'KEEFE:

Yes, sir. Well, thank you, Senator.

I don't disagree that we've got to constantly work to open the communications to garner and divine everyone's best judgment, advice and opinion on the engineering and technical challenges we experience on a regular basis. There are two things that apply on this one, I've come to, looking at the record and all the e-mail traffic and all the reviews of what's occurred here.

The first one is that in this age of modern information technology, what we have created -- again, as a consequence of it -- is a very egalitarian process. When you look at the wiring diagrams of who was talking to who, who was e-mailing who, it was independent of where they fit on the overall hierarchal chain.

There is nothing monolithic about how that approach was taken. Indeed, you have junior engineers communicating with very senior people in the organization on what they thought, and responding on that basis.

So the mission management team that conducted the in-flight operations coordination effort encouraged and received an awful lot of commentary from not just the folks within the space flight community, but outside of it, and solicited commentary from others. So that part is the good news.

The problem is it's much like anything else -- where you are encouraging volume, it becomes a cacophony. You can't quite put it in context. And therefore, judgment calls get made.

And that's the second part that really is a pattern here that concerns me a bit. We engage in an unbelievably rigid process leading up to launch. The flight readiness reviews and so forth, everything prior to that is a very methodical effort that is a very hard lesson learned from Challenger, in which everyone is encouraged to pipe up. There is all kinds of interaction.

And then as soon as the operation begins, it becomes a group of folks in the mission management team. Now this derives from, I think, a very tried and true kind of military operational procedure, in which you want to hear lots of commentary, but in the end, somebody's got to have the operational control of how this works and make decisions about it.

There is a little less of a rigidity to that process for a good reason, in order to maintain flexibility and to be adaptive to circumstances as they present themselves. But nonetheless, this clearly, this indicates that yes, indeed, the premise of your question is right on.

We need to really examine this carefully, not because there isn't enough interaction. But its quality is confused. It is in volume but not in any organized manner. And in terms of how the operational management of a mission is conducted, it doesn't lend itself as well, from what I can divine, towards any prioritization of those observations.

So yes, indeed, sir, I am committed to that, looking at how we overhaul that function and encouraging what's good about it and figuring out how to put some organization to it to make it meaningful.

ALLEN:

The other area I wanted to ask about, we talked obviously about one of the recommendations -- the preliminary recommendations -- of the accident board, with respect to the imaging. And I'm pleased to see that you would have handled that one differently.

But what about the other recommendation calling for a comprehensive inspection plan to look at the structural integrity of reinforced carbon-carbon system components? Now this again is a preliminary recommendation from the accident board. But certainly people have asked me, having been involved in these issues, why something like this wasn't done before the tragedy.

And I'm sure there are some technical kinds of questions in this area. But I'd like to get your response for the record on that.

O'KEEFE:

Yes, sir. Thank you, Senator.

Indeed, this is an area that the finding and the recommendation of the board -- and I'll defer to Admiral Gehman in terms of the approaches they looked at to come to this conclusion -- but nonetheless, their finding and recommendation was right on the mark. These are the kinds of things that we need to develop.

The catch is I'm advised by our technical community, the engineering folks, that there is no specific, non-destructive testing method that is available to do and accomplish what is necessary while the leading edge is in place. And so as a consequence, we have worked with our friends and colleagues at the Langley Research Center to develop such a technique. Because there has been a lot of work on it. And a lot of folks have been talking about it, trying to figure out how to do this.

But there is no known technique you can just simply say, "Let's go get that approach and go do it." Instead, what it requires, you take the leading edge off and then examine it through a variety of different techniques rather than in place. And in doing so, the engineers are of the view that that, in turn, creates unintentionally the prospect that you may further damage or compromise the seals at each of the points of the leading edge itself.

So what we've got to find is a non-destructive testing method in place in order to do this. Now having said that, during the course of every OMM process -- which is the major maintenance process where you tear down the orbiter essentially every eight to 10 flights - typically they will be removed and inspected through that process or replaced if need be.

On Columbia, I believe -- and I'll defer to Admiral Gehman on the specifics of this -- but some number of those leading edge panels were replaced, but not all of them. Some were original material. And so the actual inspection of them may have been -- and certainly was -- inadequate during the course of that.

But we're trying to develop a technique that would do just that.

WYDEN:

Mr. Chairman, if we could just get the admiral's response. Because I think the point Mr. O'Keefe was talking about is to have really done the job as comprehensively as the administrator would have liked, you needed to develop some technology. But there was -- I think I caught in the administrator's comments -- some flaws, even in terms of the inspection process that was used.

If that's the case, admiral, could you tell us your thoughts with respect to the flaws in the inspection process? Because at least I have not heard that on the record.

GEHMAN:

Yes, sir. Thank you, sir.

Once again, I will differ slightly in my analysis than the administrator's analysis. Of the 44 panels on the two wings of the Columbia, the 44 RCC panels, only three have been replaced. The other 41 are original equipment, 25 years old.

The question is: does anyone know whether or not those carbon laminate pieces, which are not fiberglass, but think of fiberglass, which are subjected to weather and lots of other things, does anyone know the condition of those panels? And the board was not satisfied that, like any other aircraft which is approaching its 20th or 25th year, an extensive amount of aircraft aging analysis is done. The board was not satisfied that a similar engineering kind of pattern was being followed by NASA.

And indeed, every once in a while, some of these panels are returned to the manufacturer -- for example, if there is a visual flaw. And the manufacturer does this introspective, non-destructive kinds of testing. And guess what? On occasion, we find flaws -- serious flaws -- which are not visible to the naked eye.

That led us to believe that we have a condition here -- we have an unknown condition. The board is not saying that there's anything wrong with those RCC panels. The board is saying that NASA doesn't know the condition of 25-year old panels and that this is a big flaw.

And we, of course, wanted to make sure we didn't say anything that was factually incorrect or anything like that. So we consulted experts inside, outside NASA. And oh, by the way, when we consulted experts at NASA, we got the same pushback that the administrator got.

"Oh, by the way, the systems are not perfect. Yeah, we'll have to take them off in order to do this." And we found that to be not relevant to our discussion.

You cannot fly an orbiter with 25-year old pieces of equipment that you don't know the condition of them.

WYDEN:

Mr. Chairman, thank you.

MCCAIN:

Senator Snowe?

SNOWE:

Thank you, Mr. Chairman.

How many people would have been involved in this whole decision making once it was recognized, after the shuttle launch, that damage had been done?

O'KEEFE:

I would have to get you a head count for the record. But the mission management team is composed of folks from the Johnson Space Center, the Marshall Space Flight Center, Kennedy Space Center. And primarily at Johnson, because Mission Control is operated there, out of Houston.

It is a fairly large number. But let me get you a precise one for the record here. I couldn't give you an exact...

SNOWE:

Could it be as many as 100, do you think?

O'KEEFE:

Probably less than that.

SNOWE:

Less than that.

O'KEEFE:

In terms of active members of that team, there may be that many -- or more -- folks who are actually being tasked or required to participate or whatever else. But in terms of decision makers, you've got a very specified number of folks there.

SNOWE:

And how far up the chain of command does a safety-related question go on the day of the mission?

O'KEEFE:

The mission management team is run primarily by the shuttle program, which reports primarily to the Office of Space Flight in Washington, as well as to the center director in Houston. A safety issue would escalate all the way through that process quickly if the mission management team were of a mind that we had a safety of flight consideration.

SNOWE:

They didn't obviously identify this as a serious safety- related issue?

O'KEEFE:

They did not determine that, based on all the evidence, that there was a safety of flight consideration during the 16-day mission. That was a judgment call made by the mission management team, indeed.

SNOWE:

It just seems to me that there is no question that the whole decision making process and communication and the bureaucratic structure that goes up through the chain of command has to be significantly altered.

Admiral Gehman, you mentioned that no one is responsible. But that's the problem. When you have a committee of 100 or less, no one is -- you know, if everybody is responsible, no one is responsible. It's true.

I mean, it has to change, I think, before any next launch, among other things. Because we have to get to the root causes. It just appears to me that it was a very complicated decision making environment, when it came to making these kinds of decisions. And red flags were not readily identified.

You couldn't access previous records or abnormalities that were associated with the Columbia shuttle. And that's also of concern. You can't have an antiquated system. If there are problems that had been identified with the Columbia shuttle on previous flights, there was no way to access that previous experience readily or quickly in ascertaining whether or not this was a serious problem.

So if there was a growing list of abnormalities, there were no red flags being raised because you couldn't access the list. And you have a very cumbersome, bureaucratic environment that doesn't raise a red flag with respect to this.

It's disconcerting because -- and I don't know if this is true. I read this in one of the newspaper accounts, talking about there was a memo that named over 30 high-risk concerns regarding tanks and foam and identified the idea of foam shedding from the tank and causing damage to the thermal protection system of the tiles and panels.

But over time, the space agency had come to classify the problem as a maintenance issue and not a serious threat to the safety of the craft or its crew. But even though it might have been considered a maintenance issue, the fact that it was on a list of 30 high-risk concerns should have raised a red flag.

O'KEEFE:

Senator, if I might, I want to disagree just a bit with the assertion that there were not -- there wasn't enough dialogue or exchange or whatever else during the course of this. There was plenty of that.

And ultimately, there is accountability. There are people that can be identified very clearly as to who makes decisions about this during the mission management activity, during on-orbit operations. And they are very clearly specified in terms of how they make those choices. The audit trail is pretty clear on this.

Having said that, it's a judgment call. And what they came to was -- and that's the hard part of this. This is the much tougher conundrum about this than any other aspect.

It's not that the information wasn't available. It was analyzed and deemed to be within the context of safety of flight considerations.

That was a judgment call. And you are right. There were several different high-risk items that were identified. And those were all identified as things that need to be treated.

But during the course of operations, every previous flight -- and yes, indeed, that information was available -- that demonstrated and was reviewed during the course of flight readiness reviews and so forth, but determined not to be a safety of flight risk consideration. It needed to be fixed, but not something that would compromise the mission.

It is just a -- you know, last June, we shut down the operations of the space shuttle program for the better part of four-and-a-half months after identification of a hairline fracture in a fuel line. Now that was identified as a safety of flight consideration on those kinds of high-list issues. Therefore, stop everything until we fix that.

And that's the difference. In some cases, there are all kinds of different abnormalities that you will find on every commercial aircraft, on any military aircraft, no matter what it is, that are requiring of corrections, but not determined to be safety of flight. That was a judgment call. And we'll find out in this investigation whether that was an accurate judgment call. And certainly, there appears to be plenty of doubt on that.

SNOWE:

If the photos had been able to show damage to the carbon- carbon leading edge that Senator Wyden was referring to, would anything have changed?

O'KEEFE:

Absolutely. No question. If there had been something, any evidence at all to suggest that there was a safety of flight consideration, it would have gone to five alarm fire status, where everybody would have been absolutely beating to parade rest every possible idea of how to correct the problem.

GEHMAN:

Senator, may I comment on that?

SNOWE:

Yes, thanks.

GEHMAN:

The board is probably going to spend a good fraction of the time or the linear inches of our report on this subject. And we have looked really hard at the question that you asked of: why do we have all this dialogue going on but not transmission of any messages? There is all this talking, but nothing is being transmitted.

And the board is taking an interesting approach to this, and that is the approach is that if you look at the O rings on the Challenger and you kind of backtrack on how that decision failed to get made and if you take the foam and the photographs on the Columbia and you backtrack and you say, "Oh, look, they missed something," we find that to be kind of unfair because hindsight is wonderful.

So the board has said, "Let's look through all the waivers and all the anomalies and all the steps that NASA has waived on all the flights and see if there are other items like this in which we continuously have these waivers and the acceptance of anomalies and are there other things like this going on? And is it symptomatic of some process which is not working very well?"

Because to pick these two incidents and work backwards doesn't take a whole lot of introspection. That's pretty obvious. So the board is interested: are there others out there? And if there are others out there, how did they come to be accepted? And how come we're still flying?

We have found others. And what we are doing is we are trying to find out whether or not there is a process flaw which is not allowing safety items and engineering items to get up to the level that they should.

We find that to be more intellectually honest than to go back and thrash people for what they should have seen on this one. And we have found what we believe to be some good analysis and good data which will help this process in the future, not just beat up on people for the past.

SNOWE:

I couldn't agree more. And I think looking prospectively and addressing the root causes so that it doesn't happen again, I agree. Thank you.

MCCAIN:

Senator Breaux?

BREAUX:

Thank you, Mr. Chairman. Thank the witnesses.

I have two points. First is, it seems that a great deal of the investigation leads to the conclusion, I guess, that damage to the leading edge of the left wing caused part of the problem. The question then becomes: what caused the damage to the leading edge of the left wing?

And the speculation has been that the foam coming off at the time of the launch hit the leading edge and caused some deterioration to the panels. And I know that you all have been testing that theory by some type of a mechanism that through or shot the foam towards the leading edge to see if it possibly do that type of damage.

What can you tell us about the results of that test so far?

GEHMAN:

Yes, sir. The testing started last week. We are indeed shooting pieces of foam at test articles that are orders of magnitude larger than have ever been done before. This testing has been going on for years and years and years. But the tests -- the shots -- have always been tiny little pieces of foam at tiles and all that kind of stuff.

And of course, that then leads to this erroneous analysis of how much damage to the tiles. But that's another story.

We started by shooting foam at -- once again, this is the first time that foam of the size that came off this time has ever been used as a test. We started shooting at the wheel well doors, because as you may recall, six or eight weeks ago, we suspected that the heat was getting in through the wheel well door.

The recovery of the on-board recorder changed all that. We are now building a leading edge test target. That will not be ready until the first of June.

The first couple of shots that were conducted by Southwest Research Institute were very, very mild angle of impact kinds of shots. Little or no damage was done. The angle of impact underneath there was much shallower than was actually experienced in real life.

As we start to crank the angle of impact around, the damage gets much more severe. And that's the testing that's going on now.

BREAUX:

The damage on the bottom?

GEHMAN:

To the tiles.

BREAUX:

To the tiles on the bottom, not the leading edge?

GEHMAN:

That's correct. We have not started shooting at the leading edge yet. We will start shooting at the leading edge, to get to your question directly, around the first of June.

BREAUX:

But the results of the test on the tiles on the undersurface of the shuttle indicated much more damage than had been experienced before in the test?

GEHMAN:

The damage is dependent on the angle of impact. And as we get up into angles of impact which are representative of what we think really occurs to the shuttle, the damage is more severe than previously thought. That is correct. It's dependent on the angle of impact.

BREAUX:

Mr. O'Keefe, how many times in previous launches has foam insulation separated from the fuel tank and broke off in launch or at other parts of a mission?

O'KEEFE:

There were four observable events that were recorded and analyzed as a consequence. Going back to, I think, STS-7 was the first one. There were several other events of smaller pieces, apparently, that were documented as well. But the ones that were significantly analyzed were these four different events, the most recent of which was on STS-112, which was launched in October.

BREAUX:

Is there any reports anywhere in NASA that raised a serious concern, red flag alert, that this was a problem or could be a more severe problem?

O'KEEFE:

I think for the reasons Admiral Gehman just described, there were tests that were conducted thereafter that led engineers to conclude that the impact was not, on those four significant events, was not considered a safety of flight compromise.

GEHMAN:

Senator, may I?

BREAUX:

Do you have any comment on that?

GEHMAN:

I will respectfully disagree with the administrator here. Foam coming off the external tank has hit every float on every orbiter. If you want to measure total number of hits, it's thousands. If you want to measure hits that have caused damage to the tiles of greater than an inch, it's about 30 per flight.

What the administrator was referring to is this particular piece of foam that we are talking about in this incident, which is a special

piece of foam molding that's hand-molded to cover a certain connection point called the bipod. That particular piece of foam is known to have come off six total times, including this flight. But there are over 40 flights for which we have no information; for example, the ones launched at night or when we didn't or couldn't photograph the external tank when it comes away.

So there are six that we know of out of 40 minus 113, minus out of 70-some flights. And so just to make the record straight, this particular big piece of foam, the administrator is right -- only half a dozen times. But foam hitting the orbiter occurs on every single flight.

BREAUX:

I think that's a significant piece of information for everyone to understand. I can't draw any conclusions in my own mind. But it seems to me that that might be the smoking gun. And the fact is that this isn't the first time it happened, but that that insulating foam was coming off on every flight. And on thousands of hits, damage to the tile had occurred.

It just seems to me that it was only a question of time when one of those hits did the damage that ultimately was done to the Columbia.

O'KEEFE:

Yes, sir. Thank you.

Senator, if I could, again I don't disagree with Admiral Gehman at all. I apologize for having understated this at all because it is a very significant event. There is no doubt about it.

I was referring very specifically to the bipod section. And Admiral Gehman is precisely right. This is how this has happened in each and every case. And I don't want to understate this.

The question that's really being debated internally in NASA right now is why did we permit a process that would tolerate any strike? That's the really important factor, I think. That we're really going through a soul search now, saying, "What is it that contented ourselves to believing that any strike should have been tolerated?"

And that's a much deeper process issue that really is being examined. And there's a lot of real soul search going on that says we rationalize based on historical evidence of what we thought was acceptable damage. Why would we think any level of damage would be deemed acceptable?

BREAUX:

You have just put your finger on the real question. If it had been one hit at one time, I think someone would be justified in saying, well, you know, it happened once out of thousands of flights. But it happened thousands of times. And this was probably the last time.

O'KEEFE:

Yes, sir.

BREAUX:

Thank you.

MCCAIN:

Senator Brownback?

BROWNBACK:

Thank you very much to the witnesses. And I appreciate the information you are putting forward.

Admiral Gehman, has the commission come up with any ideas on changing the decision making process to see that a mistake that

had been made in judgment this time around -- Administrator O'Keefe has already said that we clearly should have gotten imaging and there was a mistake in judgment that was made. Has the commission come up with any recommendations to change the decision making process yet that they're willing to put forward?

GEHMAN:

Senator, we have not come to any conclusions yet. But I will predict that probably a third of our report is going to be on this subject. Because we believe that that is really the lasting and the significant legacy that we can leave here.

Yes, indeed, we think that this is a systemic problem, that if you just change the people or change the names of the committees, it won't do any good, that there actually is a process problem here. And we have opinions on how to go about this. We have availed ourselves of literally dozens of experts in the area of safety engineering, risk assessment, risk management, high-reliability organizations, in order that we can write authoritatively on this subject.

I will add also parenthetically that, in your opinion, neither the Congress nor this board could get at these very, very deep-rooted institutional problems unless we availed ourselves of the investigating technique that's associated with a safety investigation, which people can speak without being fear of retribution.

BROWNBACK:

Well, who made the mistake? And who is responsible for the mistake in judgment this time around, particularly on the imagery? We've said, I think, clearly there was a mistake in judgment made at this. We should have gotten imagery.

Who made that determination? Who is responsible for that decision?

GEHMAN:

I would not characterize that decision as a mistake by any one individual. When you've got an organization which is run by boards and committees and those boards and committees don't work, I'm not sure you can blame an individual person.

So I'll have to duck that question. I can tell you which board or committee didn't work as designed. And I can tell you why...

BROWNBACK:

Which one didn't?

GEHMAN:

In my opinion, because the board hasn't spoken on this yet, in my opinion, both the boards that assess the condition of the orbiter before it's launched, which are boards and committees set up by the program manager, and the boards and committees that run the mission after it's flying, are ill-served by an imperfect system of checks and balances. And by that I mean specifically the safety organization sits right beside the person making the decision. But behind the safety organization, there is nothing back there. There is no people, money, engineering expertise, analysis.

The engineers sit right to the other side of them. But the engineering department is not independently funded. The engineers all have to charge to a program or something like that, so their allegiance is to the program. And we find that to be an imperfect system.

The boards are ill-served. You are going to get the same wrong answer no matter how many times you convene this board. And it doesn't make a difference who the chairman is.

BROWNBACK:

Well now, this is a very troubling point that you make, that you're going to get the same wrong answers. Why are we going to get the same wrong answers? These are good people. They are all well-

meaning people. Why are we going to get the same wrong answers?

GEHMAN:

Once again, I'm kind of a little bit out in front of my headlights here, because the board has not completely spoken on this, but giving my own personal view of it, we have looked -- we have availed ourselves of a very, very rich and deep academic world who studies these kinds of things, as well as industry, like nuclear power plants and petrochemical plants and things like that, about how do they do safety and how do they build in checks and balances so that the people who are making decisions are getting good, contrary opinions.

And to us, it seems that this is the flaw in the system, that unless you change the management techniques and unless you change the procedures, you can change the people sitting at the seats and they will still not get good advice.

BROWNBAC:

Well, what you are describing to me is a committee without a head or a process without a design, that just communicates a lot back and forth, but it doesn't come to a -- that there is not a responsible point at which this person is responsible for the decision making that takes place.

GEHMAN:

No, sir. I wouldn't agree with that. There is a chairman and there is someone responsible. And everybody knows who that is. But the process is not serving that person very well.

BROWNBAC:

How is the process not serving that person specifically? How is the process not serving that person well?

GEHMAN:

Because the key advisers, the people who would bring up alternative points of view, the people who would say, "Wait a minute, this is not safe," they're in the room, but they aren't supported by -- they can't come and argue their cases with 18 inches worth of documentation because they aren't funded well enough. They're not independently funded.

There aren't enough people in there to do that independent research, in order that they can come to the table and make a persuasive argument. They are kind of there by themselves.

BROWNBACK:

They are without backing, I guess.

GEHMAN:

Yeah, they are without backing. And when you get into these very technical issues about whether this is safe or whether or not this signal is important or whether or not this little anomaly needs to be paid attention to, you have to come with data.

These are engineers. You have to come with facts and data and studies. You can't just get in there and wave your arms and beat your breast. You've got to come armed with ammunition.

And so we find the safety organization is, on paper, perfect. But when you bore down a little bit deeper, you don't find any there there.

And the engineering department looks precisely organized exactly right. But then when you go bore down and find out what these 600 engineers are doing, you find that three quarters of them are funded by the program. And so you know where their allegiance is, et cetera.

So we are going to try and make some recommendations to improve the process of safety, but don't mislead -- that's why I'm giving you this unsatisfactory answer -- and I know the chairman is still looking at me -- but that's why we are trying to find a way to fix this and fix it right. But it isn't necessarily any individual one person's responsibility.

BROWNBACK:

So you need -- excuse me -- internal muscle that's separate and distinct from the program that can effectively argue within the structure?

GEHMAN:

Yes, sir. That's correct.

BROWNBACK:

For the change that would need to be addressed. Is that correct?

GEHMAN:

That is correct. Now the board is loathe to make specific organizational management recommendations for the fear of the law of unintended consequences. We aren't going to be around to manage these things and steer them. But I believe that when we write our report, we are going to give quite direct and specific guidelines on how this process ought to operate.

BROWNBACK:

Thank you, Mr. Chairman.

O'KEEFE:

Mr. Chairman, may I comment very briefly?

MCCAIN:

Sure.

O'KEEFE:

In this...

MCCAIN:

Could I comment first? When I was a young lad, the USS Missouri ran aground not too far from here. The captain was asleep in the cabin and the navigator ran it aground. The captain was relieved immediately.

But now, since there seems to be an interesting situation. No one is responsible for 9/11. No one is responsible -- excuse me, we're all responsible; so therefore, no one is responsible. No one is responsible for 9/11. No one is responsible for Khobar Towers. No one is responsible for a whole bunch of other things -- bad things -- that have happened. We're all responsible; so therefore, no one is responsible.

Go ahead.

O'KEEFE:

Yes, sir. No, thank you, Mr. Chairman. That is a perfect prelude to my respectful disagreement with my friend, the chairman of the Columbia Accident Investigation Board. There is no ambiguity on who is responsible.

There are two folks who sit at the flight readiness review: the associate administrator for space flight and the associate administrator for safety and mission assurance. They sign the order that says, "We certify this is ready for flight."

The argument that is being advanced here is that the quality of advice they are receiving, in the opinion I think of the chairman of

the Columbia Accident Investigation Board, needs further support. That's a point that we've positively got to look at.

But in terms of who is responsible, there is no question about it, who signs the certification on this case. There are identified, named individuals who are part of this mission management team.

Senator Snowe asked the question, "How many people participated in that? Lots of engineers and so forth?" You bet, lots of folks participated there. But there are specified folks with names, faces, serial names and paychecks that are provided that are chair of the mission management team and members of it that make determinations and are responsible for that.

There will be accountability here. There is no question about it. This will not be ambiguous about who is responsible at the end of the day.

We're awaiting the report. There are certain changes that have to be made. But in the end, there is no line or argument or a mush-mouthed system here of how these decisions are arrived at. There are individuals who you can identify and say, "That is the responsible official."

And I think the point that's been made here is the quality of the advice that's being rendered to them may not be as organized as it should be. My attendance at flight readiness reviews in prior flights - to include most recently, I guess, the 113 -- was you look in this room and everybody and anybody who has an opinion on the quality of the readiness of the orbiter to fly are in that room. It's a big confab.

And anybody has got the opportunity to step up and speak. And many of them are the functional equivalent in the space flight community of EF Hutton. Whenever they stand up, immediately everybody recognizes them and they stop everything until the issue is resolved.

In the end, that judgment has to be rendered by two people. And that's very clear in the way this process works.

The same is true during an operational mission management team. And the issue, I think, that Admiral Gehman is raising is: what is the quality of that advice? How is it organized? And how do we make it more relevant for them to make the kinds of decisions they are asked to make?

BROWNBACK:

Mr. Chairman, could I respond to this? Because I want to bore in on this point because it does seem to be very important.

What I hear the admiral saying is that he is saying there is not a muscle, an independent muscle behind this that's challenging this process internally; that the people, the engineers and the others that are commenting are part of a systemic system that's funded, that's one system. And it needs an independent muscle that's there in the room, that can speak from engineering data and specifics that can challenge the decision making process.

Is that correct, admiral?

GEHMAN:

That is correct. And by the way, Senator...

BROWNBACK:

Now if I could?

GEHMAN:

Yes, that is correct.

BROWNBACK:

If I could, Administrator O'Keefe -- and I'm not here trying to point fingers, but I'm trying to figure out how we keep this from happening again. We don't want anybody to die. You don't want anybody to.

Do you agree with that assessment that there is not the independent muscle behind the challenge process internally in making these safety and engineering decisions?

O'KEEFE:

Again, I am guided by the view of the board. And if their view is that it is inadequate, that's the answer. It's inadequate. And we will go fix that.

BROWNBACK:

Thank you.

MCCAIN:

Admiral Gehman, did you want to make an additional?

GEHMAN:

Thank you very much. As I indicated, we on the board have grounded ourselves -- we think -- in aerodynamics and thermodynamics and physics to the point where when we write on what caused this accident, it's unlikely that we are going to get challenged on any of our findings.

In order for us to write on this subject, we have had to ground ourselves in the -- what we in the United States know about these very complex management techniques. And so we have done that, to a great extent.

And two of the principles that have struck me get to the point where, indeed, the person who is the chairman of this board or the chairman of this committee or the two people who have to sign the

paper, they are identified by name. We know who they are and you know who they are.

But so many of these experts in this area have told us that just picking on those two people and firing them or something like that won't prevent this from happening again. If you've got a flawed process, the next chairman is going to make the same mistake, probably. So we're quite driven by that.

The second thing that we're quite driven by is writing out of a report that I would like to acknowledge other people here. But the writing goes along the lines of this, this way: that the wonderful engineers who give us all these magical things also make a pact with the devil.

I'm thinking about like things like nuclear power plants and petrochemical plants and dams and things like that and space shuttles. That you get all these magical things from engineers, but the pact that you make with the devil is you have to be vigilant forever because now you've got this dragon by the tail.

And it could be that in the 25 years or 20 years of this program, as the conditions of shuttle life changed, the board is looking at whether or not this "vigilant forever" law has been observed. Or somehow, have we migrated away from that? And the board is going to try to write on that.

MCCAIN:

Senator Nelson?

NELSON:

Thank you, Mr. Chairman.

Senator Brownback, I want to pick up on your line of questioning. But first, I want to say, admiral, thank you for your public service. Thank you for the public service that you rendered even after your

retirement, with regard to the Cole investigation. Thank you for your public service for this.

And it is this senator's hope that you are going to succeed. And that's what we want to see, that you succeed.

In the line of questioning from Senator Brownback and in your response earlier with regard to the safety process that had been set up 17 years ago. And your quote was, "There is no there there." Now that makes my blood boil. Because of the communication problems 17 years ago with Challenger, which in large part was that was the reason for the destruction of Challenger, that information could not flow from the bottom up, it was much easier flowing from the top down.

And so this process of safety was imposed. And the safety process was supposed to be an automatic failsafe. But you say there is no there there.

Why do you think we haven't learned the lessons from Challenger, as painful as that was?

GEHMAN:

Senator Nelson, thank you very much for your vote of confidence. We will see whether or not it's well-founded or not.

But the board is going to spend an enormous amount of energy to answer that very question. It's possible -- it's possible -- that we have the system that we have right now because of Challenger. There were recommendations to consolidate, have a more formal chain of command, have a more strict and monolithic program, that were part of the Challenger recommendations.

And once again, I don't want to get ahead of myself. But we're going to look at this in great detail.

We have also looked at best business practices from other very, very risky communities and have found how they do high reliability kinds of things. And the board will attempt to write an outline that will ensure that these kinds of safety issues do, indeed, get raised to the right level and the people that have to make the judgments are advised well and that these issues are not submerged.

I don't want to get into any more detail than to say that, at this time, the preliminary -- at this stage in our report, I am willing to volunteer that we are not completely satisfied that underneath the box that says safety and S&MA, that there is a big, robust organization which allows the person in the box to speak, to come to the table with the same number of chips as everybody else.

And under the box that says engineering directorate, that there is not enough independent, good old engineering kind of think that NASA used to be known for, to come to the table and bang on the table and say, "You're wrong and I can prove it." That's about as far as I'm willing to go at this time.

NELSON:

All right. Let me nail down something that the chairman and Senator Hollings said earlier, ask you about, with regard to our congressional oversight. I need to know, specifically for the record, since you are trying to protect the identity of the witnesses, since you want to encourage people to come forth and tell the truth, without having to subpoena them for the truth, understandably, you want to protect their identity.

What we need to know is: is that testimony, that full testimony, available to this committee in our congressional oversight capacity?

GEHMAN:

The short answer is we are in the process of working out an arrangement by which you will have access, by some process, to all that information. The answer, the short answer, is yes.

If I may just say that the purpose of giving witnesses guarantees of anonymity is not so they're tell the truth. That's not the issue. They will tell the truth when they come up here and raise their hand.

The purpose is to find out things that they would not volunteer under questioning. That's a whole different range of information, a whole different body of insights, in which they may say something that they are not fully sure of, for example. It's a feeling that they have or something they can't prove or something like that, which they would not give to anybody which was doing this in a public forum.

NELSON:

Well, there was some question in Senator Hollings' mind. I'm glad that you have clarified that, that the answer to the question is yes.

Let me comment. I happen to agree with your statement about the old timers; that the old timers, basically, if they knew there was a potential of a problem, they would have started working it. They would have done photos immediately. They would have started pulling out of their hip pocket every possible theory of changing anything that could be changed, as well as what Senator Hollings had said: coal soaking; no roll reversal to the left; maybe a different angle of attack.

What do you think? Why did NASA and its leaders tolerate? I guess the question is: what is your report going to tell about reenacting this, of how you would do it, pursuant to the old timers?

GEHMAN:

The old timers certainly taught me something, which I find compelling. In the business about photos, for example, on-orbit photography, they would say, "It doesn't make any difference

whether you could have done anything to save this crew or not. We would have taken photographs just so we would have known what happened."

I mean, the old timers are more flight test, test pilot kind of attitude, that even though the loss of the crew is terribly regretful, if you have a test pilot kind of an attitude, you always want to know what happened, so that they didn't die in vain. So of course, we would have taken photographs. You wouldn't have had to prove that there was a foam strike. All you had to do was scratch your head and say, "Hey, I don't think I know what happened here." And the next thing, all the lights would have gone off.

And so that's compelling to me. In other words, you don't have to prove that somebody made a mistake or you don't have to prove that an error in judgment was made. The old timer attitude would have got you photographs just because.

And maybe we couldn't have done anything about it. But maybe we would have known what happened in this particular case. It's more of an intellectual inquiry kind of an attitude.

Senator, you weren't in the room when I mentioned earlier that we and NASA have just begun -- 10 days ago -- a very in-depth and aggressive analysis of what could have been done. And I mentioned that we couldn't have done this earlier because there were too many emotions. Everybody was too close to it.

But now that we've got a little time separated and we at the board know a little bit more about this, together we are looking very, very hard at what might have been done. But I don't really know that, even if we find an answer -- you know, "put duct tape on it" or something like that, I don't know -- that it can result in whether or not we could have saved this mission or not. I just don't know.

The only thing I do know -- and I know that the administrator agrees with me -- is that we would not have done nothing. I mean, that's not

the way we do things. We would have done something, even if it only had a 10 percent chance of saving this.

We would have -- there were two EVA suits on board. They could have gone out and taken a look at it. They could have put duct tape on the thing.

I mean, I don't know. I'm just making that up, of course. But they would have done something.

MCCAIN:

Senator Sununu?

SUNUNU:

Thank you, Mr. Chairman. I want to begin by exploring this issue of accountability that the chairman raised.

Admiral, I think you said something to the effect that you don't want to pick on those that are responsible for signing off on the flight security because if there is a flawed process, even if you have a replacement, you will still have a flawed process. And I would maybe differ with that just slightly.

The chairman used an example of the Missouri. I think that ran aground. Now I don't know that they changed the process or not. But my guess is not only did the subsequent captain not run aground, I bet the Missouri has never run aground since.

So we don't want to single anyone out inappropriately. We want the criticisms to be based on good information, good analysis. But I do think there is something to be said for a system that does hold those in a position of responsibility accountable, even if there is a flawed process and even if you are not sure you have implemented a perfect process.

Because a system that holds individuals accountable will create an incentive for those in a position of responsibility to do everything possible to make sure the support systems, the processes that help them make decisions are good ones. Would you agree with that?

GEHMAN:

I support your comments completely. I come from a system that that's the way we do business. And I have no problem whatsoever with the process, the administrative processes of NASA and the Congress and the administration to taking whatever steps are necessary, if you think someone's performance was lacking. It's just not the function of this board.

Now you will be able to tell from my report where to go looking. We're not ducking the issue. It's just not the function of this board. The function of this board is to try and make space flight safer -- find out what happened and try and make space flight safer in the future, if we can.

And we believe we will be able to do that for you. And if we found that someone had not executed their duties in accordance with NASA regulations, we will note that. But that's not the purpose of this board.

O'KEEFE:

Senator, if I could? I think at the conclusion of this investigation, when this report is finalized and after the agency takes said actions to implement those findings, I am confident you will find no ambiguity on this question of accountability at all.

SUNUNU:

Excellent. Thank you.

Senator Breaux, in his line of questioning, talked about the foam insulation breaking loose. And I want to be clear on what you said.

I think you indicated that there had been 30 impacts -- approximately 30 impacts -- that had resulted in a specific amount of damage.

GEHMAN:

One inch.

SUNUNU:

At one inch? Or I take it that's one inch or greater.

GEHMAN:

One inch or greater, per flight.

SUNUNU:

There have been an average of 30 impacts per flight that had resulted in damage of one inch or greater. And can you describe, when you say damage of one inch or greater, can you give us a little bit more background and detail as to what type of damage that is, in what part of the shuttle?

GEHMAN:

Yes, sir. It's on what we call the acreage tile, the 25,000 individual tiles like this. And we're talking about a divot, a chip that's greater than one inch in any dimension. And underneath this black is white. So if you chip this, it's pretty obvious. So a chip in the tile anyplace on the orbiter in the thermal protection system that has a dimension in any direction of greater than one inch.

SUNUNU:

Thirty an average number? Or...

GEHMAN:

Thirty is an average number.

SUNUNU:

Talk to me a little about the standard deviation. I mean, did it vary greatly from flight to flight? Or was it pretty consistent that you would have 30 impacts of that nature?

GEHMAN:

With the exception of four or five flights in which there were tremendous variations, up in the hundreds. And these were accounted for.

For example, when NASA changed what we call the blowing agent, the air power behind the foam application in accordance with EPA regulations to stop using Freon on the very next tank that flew with the new blowing agent, the number of divots was up in the hundreds. They immediately knew what the problem was and they changed blowing agents. It had gasified in a different way that they hadn't anticipated.

So they fixed it. And the next time it went back down to 30, just like that.

I will also tell you, Senator, that the trend over all 113 flights, it's flat. It's not getting any better.

SUNUNU:

There seems to be or have been a process to measure and quantify the damage from these impacts. Was there any process, albeit unsuccessful from your description, to address or reduce the number of impacts?

GEHMAN:

There have been steps taken. There have been discussions, meetings, studies, analyses, to reduce it. Unsuccessful.

And while our audit -- we call it an audit. We call it following the foam. There is a foam audit going on right now, all the way from the first flight, to try and go through the records to see what the records say that these various boards and committees did to adjudicate: what should we do about the foam?

And generally speaking, the records kind of just die off. I mean, the issue just kind of goes away. It's never actually really addressed in an engineering point of view.

SUNUNU:

When did it go away?

GEHMAN:

What happens is, is that the foam hits the orbiter, there are a couple of significant issues. It appears on the FRR -- the flight readiness review -- and various materiel boards. They study it real hard to see what they can do about it.

They have four or five more flights in which there are only minor problems. And they say, "Well, it looks like it's not a big problem." And then what happens is that success clouds their engineering judgment.

They say, "Oh, look. It's still happening. But nothing bad is happening. It looks like it's okay."

Then another couple of years will go by and something big will happen. It will appear in the records again. Some studies will be ordered. Some engineering analysis, maybe a fix. And then the numbers go back down to reasonable numbers and success again breeds this attitude that it looks like it's okay.

SUNUNU:

But it's fair to say the average number of impacts, over the last, just say 20 flights, was relatively constant?

GEHMAN:

All the way from the first one, it's relatively constant.

SUNUNU:

The issue of space debris was raised during some of the early press accounts, guesswork, hypothesis of what might have happened. I assume that's been reviewed pretty thoroughly by the board. Is that concern or question still a possibility as a cause of damage, or perhaps something that made existing damage worse while in orbit?

And on a related note, have you learned anything or come to any conclusions about our ability to track and to deal with the threat of space debris to future flights?

GEHMAN:

The issue of the possibility of the orbiter being hit by space debris is unresolved by the board at this time, after a lot of work. The board understand the ability of the United States to track space debris down to a certain size. And the board understands how the orbiter is maneuvered around in intersection -- you can call it conjunction -- with space debris down to a certain size.

But then micrometeorite debris, the little tiny stuff that we can't track, we don't even know is out there, remains an open issue. And we have attempted to get at this issue by a number of very clever ways.

The orbiter has some very, very sensitive accelerometers on board that the output of which is recorded on board in knot telemetry down

to Earth. It turns out that the recovery of this data recorder, which is a miracle, has allowed us to read out those accelerometers.

There are a couple of little jiggles in those accelerometers, which suggests that we need to look harder at that. But we cannot rule out a tiny little micrometeorite kind of a strike.

SUNUNU:

Final question.

MCCAIN:

Time is expired.

SUNUNU:

May I ask one final question?

MCCAIN:

Sure, go ahead.

SUNUNU:

I think it's a short answer. In hindsight or looking back to the very first few days of this investigation, which was a difficult time for so many people, is there anything at this point that you would look back and say, "You know, in hindsight, in the first few days, I do wish we had taken a particular step or we had structured things slightly differently or taken some time to facilitate a particular task?"

Anything that you could identify, administrator?

O'KEEFE:

I guess as a personal and professional philosophy, my attitude is: make the best decision you can, based on the information you have at the time and move on and continue to progress. I don't spend a

lot of time thinking back to what we might-a, could-a, should- a, would-a.

I think it is as professional and as straightforward a process as I know how to do. And it was within hours that not only the NASA team, but also the Columbia Accident Investigation Board was impaneled. And the investigation began immediately.

Everybody followed a contingency plan that I had personally reviewed several times, in the event something like this could happen, and was very content that, starting at 9:29 that morning, the first action item on that contingency plan was actionable. And we followed the procedure exactly the way we had talked about it.

Secure in the knowledge that we would likely not ever have to use it, we nonetheless had to. And I just can't look back on that and really revise the history of it.

If I could, very quickly, Senator, just observe one point, I think, in the discussion here that you have had on the strikes? The tile damage on each and every flight, Admiral Gehman has got it exactly right. Some of it comes from foam strikes. No question about it.

And there are many other things that will also damage the tile. Of those 25,000 tiles that are aboard, as soon as every orbiter has landed, the first thing the commander wants to do first -- and Senator McCain will appreciate this -- is they want to make sure that the wheels are right on the center line of the runway. That's the first obsession on the part of every commander.

The next step, though, is to walk around the orbiter and observe every one of these strikes. And there are lots and lots of streaking that occurs on the tiles. And based on the condition of those tiles, they're either replaced or repaired in between flights.

And the issue that I think Admiral Gehman is talking about -- so in other words, there's a lot of contributing factors. Not just foam, but

plenty of other incidents that will occur on orbit or on reentry, that will create a visible kind of damage to the tiles on board the shuttle itself. And each of those are either replaced or repaired.

But the issue, I think, that Admiral Gehman is raising, that really, really is a point of deep consternation with us right now, that we're really doing a lot of soul searching about, is there are certain aspects of this that were tolerated because it had this exacting kind of "no unusual circumstance out of the norm." And so what academics are referring to is the normalization of deviation -- as in, if you see it so many times, you finally consider it to be an acceptable condition -- is the issue. That's the point we're really doing some deep soul search about.

And as we talked about earlier, why we ever got into a position where we tolerated anything greater than zero on this is the point we're really debating among ourselves right now and trying to determine how we create a system that would never tolerate that kind of circumstance again. And it's not just foam. It's the range of things that could tell you, in a trend, what could potentially become a deep compromise to safety of flight consideration.

That's the deeper issue that I think is being raised by the board, that we're hearing in public testimony, we're hearing supported. And we're clearly seeing evidence of that concern. And we're wrestling of how do you adjust that process to assure that kind of understanding in the future?

SUNUNU:

Thank you very much.

O'KEEFE:

Thank you, Senator.

MCCAIN:

Mr. O'Keefe, did you request \$15.5 million for the Institute for Scientific Research in Fairmont, West Virginia?

O'KEEFE:

No, sir.

MCCAIN:

How about \$7.6 million for hydrogen research being conducted by the Florida State University system?

O'KEEFE:

Not that I'm aware of.

MCCAIN:

\$2.25 million for the Life Sciences Building at Brown University, Providence, Rhode Island?

O'KEEFE:

Not that I'm aware of.

MCCAIN:

You notice that each of these are geographically specific. How about \$1.8 million for the construction of a Gulf of Maine Laboratory at the Gulf of Maine Aquarium Foundation? Did you request that?

O'KEEFE:

No, sir. Not that I'm aware of.

MCCAIN:

How about \$1.35 million for expansion of the Earth Science Hall at the Maryland Science Center in Baltimore, Maryland? Did you ask for that?

O'KEEFE:

No, sir.

MCCAIN:

I understand also you are paying for a bug exhibit in Chicago -- or were. I saw that on one of the networks. Did you see that?

O'KEEFE:

I'm not aware of it, sir.

MCCAIN:

And yet, your budget has been largely flat?

O'KEEFE:

About a three percent increase last year and projected, if Congress will tolerate, about a 4.5 percent increase this year that we hope for Congress' support of.

MCCAIN:

I'm talking about in previous years.

O'KEEFE:

Yes, sir. In prior -- yes.

MCCAIN:

Well, in the issue of responsibility, Admiral Gehman, I hope that you will, in your deliberations, if there is programs -- critical programs --

that have been underfunded in this pork barrel spending, which is in the hundreds of millions of dollars over the past few years -- hundreds of millions of dollars -- unrequested add- ons, some outrageous, some not so outrageous. Some of it may be good things. None of it requested. As I mentioned earlier, it went from, in 1998, from \$24.7 million to \$167 million in 2003.

I hope that the board, when we're talking about responsibility, will talk about the responsibility of Congress to spend these monies that are earmarked for NASA, that are supposed to be for programs associated with NASA, rather than pork barrel spending, and whether that may have impacted the funding of critical programs. I hope that the board will be looking at that, Admiral Gehman.

GEHMAN:

We will, sir. We were going to look at budgets. And \$100 million will buy a lot of safety engineers.

MCCAIN:

Thank you, sir. As I mentioned, last year was \$167 million. And some of it, it just staggers the imagination. It has no more relation to NASA -- well, anyway.

I have one additional question, Mr. O'Keefe. We all know what happened with the Soyuz capsule. Steep angle, 10 g's, 300 miles away, no radio communications. Are you confident that that is a vehicle that should be used in this interim period? And if not, what are the options?

O'KEEFE:

Certainly this was an outside the norm landing pattern. It was the first upgrade -- I'm sorry, it was an upgrade of the Soyuz capsule. And it was the first time that specific upgrade module had flown.

The Rosaviakosmos, the Russian space agency, is conducting an investigation now. We are a participant. And we've got members who are involved there. We've got a significant team of folks who are resident in Moscow and in Star City, who are working with the Russian engineers to determine exactly how this particular abnormality occurred.

But it is not outside the envelope of what would have been expected. A ballistic reentry can and does occur -- very infrequently, but it did. And in this particular case, trying to determine exactly what caused it in this particular case is what our objective is all about.

Having said that, it has not posed a safety of flight factor. And it's not one that our outside folks -- General Stafford and others, who have reviewed the flightworthiness of the Soyuz -- have concluded that it is a more than acceptable flightworthy craft for the purpose of the effort we're engaged in now, to replace the International Space Station expedition crews.

So our confidence is still very high. It was, no question about it, the better part of two-and-a-half hours of extremely anxious period and four hours before we were able to get a visual, look them right in the eye determination that yes, everybody was okay.

But all the commentary from everyone, I met with all the crew immediately after they returned to Star City that day. And they found, while it was an exciting trip, it was not, nonetheless, something that they were untrained for. They knew that was within the envelope of how that happens.

MCCAIN:

Ten g's is a pretty interesting experience.

O'KEEFE:

It was really exciting. Yes, sir. No doubt about it.

MCCAIN:

Senator Nelson has promised me that he will take a maximum of 10 minutes, realizing that you have already been here for well over two hours. And I appreciate his involvement, his experience and what he brings to this committee on a variety of issues, but particularly on this one. He's also a man of his word -- 10 minutes.

Senator Nelson?

NELSON:

Mr. Chairman, as long as they don't give 10-minute answers.

(LAUGHTER)

Mr. O'Keefe, were you aware of the piece of debris that left the shuttle on flight day one?

O'KEEFE:

No, sir.

NELSON:

Who was aware? And would they have had a responsibility of telling you about that debris?

O'KEEFE:

Let me give you a full list of all the people who were aware of that particular incident.

NELSON:

Make it short because I've got lots of questions. And he wants to keep me...

O'KEEFE:

We will provide that for the record, sir.

NELSON:

Okay.

GEHMAN:

Senator, the piece of debris orbiting the shuttle on flight day two was not discovered until six days after the accident. Nobody knew about this thing when the flight...

NELSON:

Thank you for sharing that. Well, given the fact of the multiple thousands of hits from foam in the past, how far -- did the safety people directly engage in a discussion about the foam hits?

O'KEEFE:

I'm advised they did as recently as the STS-113 mission, which was the one immediately preceding 107. There was discussion at the flight readiness review of the foam strike of significance, the bipod strike that had occurred on 112. And they had reviewed that particular matter.

NELSON:

Well, admiral, of course that will be a main part of your investigation.

Admiral, when do you expect your commission to issue a report?

GEHMAN:

We're event driven. I would characterize us as finishing up the investigation phase right now. And we're beginning the deliberation. We're going to move here to D.C. the first week in June and begin writing. It would be my goal, assuming that the board can move

along with me, to have our report delivered to you prior to the August recess.

I have to caveat that. That's my goal.

NELSON:

Are you contemplating that you are going to recommend that the vehicle should be fully recertified?

GEHMAN:

I'm afraid I'm going to have to duck that question because we haven't got to that point yet. Every time we come to a conclusion about a recommendation, we issue it as soon as we can. We have a number that are percolating up right now. And that's not one of them.

NELSON:

And of course, as I said at the outset, it's enormously important to us that you are successful in this and that we can get on and get the thing fixed and start flying again.

Now in view of that, Mr. Administrator, I wanted to ask you: what are you anticipating in the way of an impact on the shuttle work force?

O'KEEFE:

We are looking to mitigate that as much as possible right now. And indeed, folks are very busy in preparation, in working through the issues on return to flight. If anything, I think we're going to be short folks that we may need because, again, the nature of the recommendations that Admiral Gehman and the board have released thus far, as well as those yet to come, will require a diligent, extremely vigorous implementation of that effort, which will require everybody in the space flight community turning to very, very hard.

NELSON:

By the way, admiral, on the previous answer, why did we not discover on flight day two that piece of debris trailing? Why was it only after the accident?

GEHMAN:

Senator, the United States does not currently track the shuttle. The United States Air Force Space Command and U.S. Strategic Command keep track of everything that's in space. They keep track of all of our satellites, including the shuttle when it's on orbit, for the purpose of making sure they don't run into each other. But we don't track it, in the sense like a fire control guidance system or anything like that watches it.

After this accident, we asked the U.S. Strategic Command and Air Force Space Command to go back over all their millions and millions of records and pull out all of their observations of the shuttle to see whether or not any damage could be detected. They could not detect any damage. But they found 3,100 observations of the shuttle due course. And they discovered in their reconstruction, "Oh, look at this. Here is something that's orbiting alongside the shuttle," which was reported to us six days after the accident.

NELSON:

Thank you for clarifying that.

Mr. O'Keefe, there is always this gut-wrenching question about whether the crew should have been told. What was the crew told about the strike by the foam and the likelihood of the damage?

O'KEEFE:

To my knowledge -- and again, I will clarify this for the record if it needs further -- they were not advised of that and were not advised of any significant damage because, again, it was inside what was

deemed on every previous flight, every time that it occurred, within the realm of acceptable and not a safety of flight consideration. So therefore, it was not raised with them specifically.

Lots of other things were. Many other issues were raised with the crew regularly. But this didn't rise to that level. It was a judgment call and one that was determined not to be a safety of flight consideration.

NELSON:

And admiral, as you make your recommendations, I would respectfully suggest that the old timers would say that they would definitely want the crew involved.

GEHMAN:

I think that, if you will let us respond for the record, Senator, I think that we can shed more light on that subject. I think there's -- I'm not completely conversant with every detail. But the crew was advised at some time. And I don't know exactly when and what day it was or whether they were consulted or not. But let us get that for the record. There are some facts there.

O'KEEFE:

As a matter of fact, on that point, admiral, and exactly right. I guess the question, as I interpreted it, Senator -- I apologize -- was: were they specifically consulted and advised about it? They received the daily flight reports from the mission management team. And on those reports was the noted incident of strike and a resolution of the question, I believe on day 12, in which unambiguously it says, "We've analyzed this, examined the issues and determined it is not a safety of flight consideration."

So it was treated as another data point. It was not something that was raised specifically.

So as you are well aware, the process during the course of on- orbit is you receive lots of data, lots of information, lots of reporting back and forth from mission control. And it comes in many forms -- some by voice, some by the notice in requirements.

But on this particular case, it was noted on the mission management team reports. And that will be provided for the record, as I think it was on February 12th at that hearing. But there was not a specific dialogue that I am aware of with the commander or the payload specialists -- I'm sorry, the mission specialists aboard that were specifically engaged in the activity.

I don't believe that was the case. But I'll provide that for the record as well.

NELSON:

Well, I know that to cut the crew out, you are eliminating a great resource. And I know that there have been many occurrences where emergencies have arisen in the past, that the crew responded immediately and had the problem fixed before mission control even knew about it. So you all will deliberate that in due time.

Well, let me just wrap up here for the chairman. And you can provide these for the record.

What I want to do is what all of us want to do. I want us to get the problem fixed and get flying and get back and utilize these wonderful assets that we have out there, including the space station. But we're going to have to attend to safety in a way that we never have. And of course, you have heard me rail from this podium in the past about, over the past decade, of the safety upgrades not being done on the space shuttle and delayed.

So if you, Mr. Administrator, will provide for the record: how does NASA determine what shuttle upgrades are required and how these

upgrades will be selected and prioritized? And does NASA have a 2020 plan to show when the shuttle upgrade requirements will be completed?

And then, if you will round that out, as we are grappling to get the technologies for a follow-on vehicle, why have we seen so many missteps in the development of a second generation technology in NASA's program?

Any comment now? Then if you would supply the rest of it for the record.

O'KEEFE:

Yes, sir. Be delighted to provide all that for the record. We are moving ahead aggressively on the orbital space plane to guarantee a crew transfer vehicle capacity between here and the International Space Station. That's its mission. That's its objective. To use then the shuttle for the purpose of the heavy lift cargo capacity, as required. That's a mid-term kind of a requirement.

We're also developing the next generation launch technologies, which will ultimately provide for a space exploration vehicle. Whether it is a replacement for shuttle or not is something we ought to think about long and hard.

Because it is only capable of orbit within low Earth orbit; it has minimal maneuverability; it has no power generation source of its own, all of which are things we need to correct from a technology standpoint, to look at anything beyond low Earth orbit. I think you will see emerge from this process an answer on that front for the longer term, what replaces this capability for more expansive space exploration objectives, in very short order.

NELSON:

Gentlemen, thank you very much. The meeting is adjourned.

O'KEEFE:

Thank you, Senator.

GEHMAN:

Thank you, Senator.

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